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ON THE RELATIVE POWER OF METALS AND ALLOYS TO CONDUCT HEAT.

By F. Crace Calvert, F.R.S., and Richard Johnson, F.C.S.

The following paper was communicated to the Royal Society, and has been published in the *Philosophical Transactions*:—

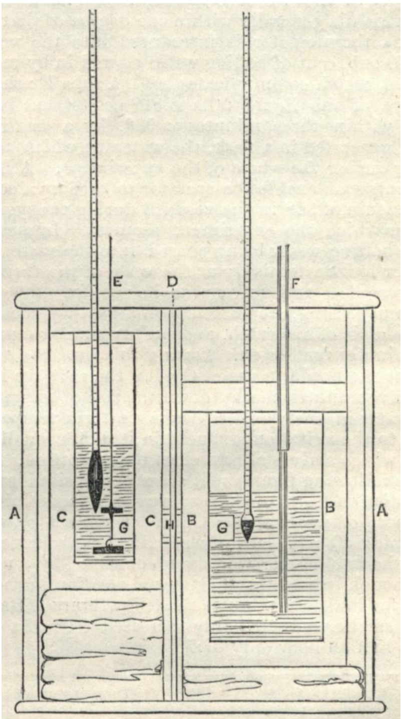
Metals and their alloys being now so extensively employed in arts and manufactures and for instruments of precision, we have thought that it would be interesting, in a scientific or commercial point of view, if we were to examine their conductibility carefully and completely.

To enable us to determine with accuracy the conducting power of all the ordinary metals, and of seventy of their alloys and thirty of their amalgams, we had to find out a new method of determining the conducting power of metals; for the process followed by M. Despretz could only give results to be relied upon for a few of the best conductors, such as silver, gold, and copper. Further, his process, which consists in having a long and thick bar of metal, so as to allow holes to be drilled, in which mercury and the bulb of a thermometer are inserted, would have required a large quantity of each metal in a state of purity, the labour of obtaining which, even comparatively pure, is well-known. Also from the fact of mercury being employed, we should have been unable to ascertain the conducting power of such important alloys as brass and bronzes, and could not have applied the process to amalgams.

The method which we have followed gives such consistent results, that we have not only been able to determine the influence exercised on the conducting power of metals by the addition of 1 or 2 per cent. of another metal, but also to appreciate the difference of conductibility of two alloys made of the same metals, and only differing by a few per cent. in the relative proportions of the metals composing them. At the same time the conditions theoretically required in order to obtain results independent of everything but the nature of the substances, are not very rigorously fulfilled, so that the term conducting power, as used by us, must be understood in a somewhat qualified sense, and as having relation to our method of determining it. We believe, however, that the ratios of the conducting powers, as determined by our method, do not differ from those of the real conducting powers.

Before describing the process followed and examining the results obtained, it is necessary to state that we have made a great number of experiments with the hope of solving the important chemical question, are alloys simple mixtures of metals, or are they definite compounds? With this view we have operated on a large number of alloys and amalgams, convinced that if the chemical nature of alloys and amalgams is still enveloped in darkness, it is because they have been prepared with impure or commercial metals, and not made in equivalent quantities. The consequence has been, that as metals have only a slight affinity to each other, and as the definite compounds which they have a tendency to form were mixed with an excess of one of the metals employed, the alloys produced have presented properties which could lead to no information as to their nature. These difficulties have been increased by the fact, that in many alloys, such as those of copper and tin, or copper and zinc, the metals have a tendency, when allowed to cool slowly, to form several crystallizable compounds, differing in their composition in the various parts of alloys; the less fusible being on the exterior, and those more so in the interior of the mass. The impurities existing in commercial metals are often so large as considerably to modify the properties of their alloys; for we have found in our researches that if 1 per cent. of a metal be added to 99 of another, it alters its conducting power most materially. To avoid these causes of error, we have composed our alloys of pure metals and employed definite proportions.

The apparatus which we used is composed of a deal box, A (see woodcut), 105 millims. in width, 165 millims. in length, and 220 millims. in height; with a cover, and painted white externally and internally. Inside this box are two vulcanized india-rubber square vessels, the sides of which are 15 millims. thick. The larger vessel, B, measures internally 52 millims, on the side and 125 millims. deep, and is capable of containing 336 cub. cent. of water. The smaller vessel, C, is 27 millims. on the side and 125 millims. deep, and has a capacity of 90 cub. cent.



These vessels are painted white and surrounded with wadding; and still further, to prevent any radiation of heat, a deal board, D, is placed between the two vessels. So little heat is radiated from the vessel B, when it contains 200 cub. cent. of water at 90°, to the smaller vessel, C, containing 50 cub. cent. at 16°, that in a quarter of an hour, the time required for our experiments, the water in the latter vessel did not rise one-tenth of a degree Centigrade. Therefore all sensible radiation and conduction was avoided, and the rise of temperature in this vessel, during the experiment, must have been entirely due to the heat conducted by the square bar of metal (G) used. This bar is 6 centims. long and 1 centim. square, and is so arranged in the experiment, that 1 cub. cent. is in the vessel, B, 1 cub. cent. in the vessel C; 3 cub. cent. are covered by the sides of the boxes, through which it passes; and the last 1 cub. cent., is covered with a piece of vulcanized india-rubber tubing, and the whole made secure from any leakage by lining the sides of the holes, through which the bar passes, with a varnish made of caoutchouc dissolved in benzine. The bar is placed 54 millims. from the bottom of D, and 12 millims. from the bottom of C.

When we desire to make an experiment, the vessels are put in water so as to equalise their temperature; they are then carefully wiped and placed in the wooden box, surrounded with wadding, and 50 cub. cent. of water, at the temperature of the room, poured into the vessel C; the two boxes are then covered with vulcanized india-rubber lids, each perforated with two holes; the vessels are covered with wadding, and the lid of the box shut. Through one of the holes in the vessel C is introduced a very sensitive thermometer, graduated in tenths of a degree; in the other hole is a small whalebone rod, B, having at its extremity a piece of vulcanized rubber to agitate thoroughly the water in the vessel during the experiment, and render it of a uniform temperature. When the water in the vessel C has attained a fixed temperature (which is generally within one degree of that of the room), a thermometer is introduced into the vessel B, and 200 cub. cent of boiling water poured in by means of a funnel, which communicates with a tube F; the temperature of the liquid falls to 86° or 88°, but is again raised within three minutes to 90°, by a small jet of steam, generated in a flask, the water in which is kept boiling during the whole of the experiment. A few experiments soon enable the operator to keep up a constant temperature of 90° in the vessel B during the quarter of an hour which the experiment requires. Immediately on the boiling water being poured into the vessel B, the operator looks attentively at the scale of the thermometer in vessel C, and as soon as he perceives the column of mercury rising, he carefully marks the second and minute dials of his watch, and makes similar marks fifteen minutes further on. During this time the operator agitates the liquid in vessel C with the agitator E, and every five minutes marks down the rise of temperature. The water in the vessel B has a uniform temperature, owing to the agitation produced in it by the small jet of steam which arrives almost close to the bottom.

The following figures will show how insignificant was the radiation from the larger vessel B, containing 200 cub. cent. of water at 90° C., to the smaller vessel C, containing 50 cub. cent. of water at natural temperature, when the two vessels were not connected by a metallic bar, though placed in their usual position in the apparatus, for in fifteen minutes the temperature of the water in the smaller vessel C only increased 0·05 of a degree, and in half an hour only 0°·7.

	Temperature of the water in the vessel C.
	Degrees.
	17·20
After 15 minutes	17·25
After 30 minutes	17·90

Therefore the entire increase of temperature in the vessel C, in our experiment, must have been due to the heat conducted by the bar.

It was found that it required twenty-four hours before the temperature of the water in the vessels of the apparatus was in equilibrium with that of the surrounding atmosphere, when 200 cub. cent. of boiling water was poured into the vessel B, and the apparatus left to cool. It might be objected that in our experiments we neglected to take into account the heat absorbed by the sides of the vessel C; but we found, from a great number of experiments, that whether we took into consideration, or not, the amount of heat absorbed, it did not affect in any degree the relative conductibility of the metals and their alloys; but it must be borne in mind that it was not the absolute quantity of heat communicated to the bar in vessel B which was determined in vessel C, but the relative facility of conduction by various metals, all circumstances being the same. The best proofs that we can give of the accuracy of the process are—1st, that the series of alloys which conduct heat in the ratio of the equivalents of the metals composing them would not have shown such a coincidence between the observed and theoretical results if our process had presented any serious defects; 2nd, that we have been able to determine with accuracy the marked influence exercised by the addition of 1 per cent. of a metal to another metal; 3rd, it will be seen further on in the paper, that we have determined with precision, that in copper bars, having different conducting surfaces, the observed result agrees with the calculated one.

The process followed to ascertain the amount of heat absorbed by the vessel C, consisted in putting into the vessel, cooled down to the natural temperature, 50 cub. cent. of water, having the temperature which the water had when the last experiment was completed, and noticing how much heat was absorbed from the water during the quarter hour. For example:—

	Mean conductibility.		Mean absorption.		Total.
Zinc cast vertically	20·03	...	8·80	...	28·83
Antimony cast vertically	6·12	...	2·50	...	8.62

but as 20·03 : 6·12 : : 28·83 : $x = 8·80$, the relative conducting power of antimony.

Therefore it is quite clear that the addition of the heat absorbed by the vessel C, to the heat of the water in the same, would have complicated our results without any advantage.

We shall only give two examples here to show how very regularly the apparatus works, and how accurately it indicates the different degrees of conducting power of two metals. The increase of temperature, in the successive five minutes, is in the same ratio whether the conductors be good or bad.

Names of the metals.	Temperature of the room.	Temperature of the 50 cub. cent. of water before beginning.	Temperature of the 50 cub. cent. of water after each 5 minutes.			Constant temperature of the 200 cub. cent. of water.	Conductibility found.	Mean.
	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.		
Pure Copper	20	21	34·4	42·7	48·0	90	27·0	27·05
	20	20	33·6	41·8	47·1	90	27·1	
Lead	18	18·2	22 0	25·1	27·4	90	9·2	9·17
	18	18·3	22·1	25·0	27·45	90	9·15	

In fact, it is owing to the facility of appreciating within two-tenths of a degree, in two successive essays, the conducting power of a metal or alloy, that we have been able to determine the precise conducting power of so large a number of alloys and amalgams, and even these researches have required more than a year's constant labour and attention.

The metals which we used were purified by the following processes:—

Gold.—About 140 grammes of nearly pure gold were dissolved in aqua regia, and the liquid evaporated to dryness. The residue was dissolved and filtered, and to the filtrate a solution of protosulphate of iron was added. The gold thus precipitated was washed with hydrochloric acid, and fused with a little borax and nitre.

Silver.—Pure chloride was reduced by fusing with pure carbonate of potash.

Copper was obtained by reducing pure oxide of copper by a current of pure hydrogen, or by depositing it from a solution of pure salt at a pole of a galvanic battery.

Tin.—Well-crystallised protochloride of tin was recrystallised, and when quite pure, was reduced by being fused with a mixture of bicarbonate of soda and lampblack.

Bismuth.—Pulverised bismuth was dissolved in strong nitric acid, the liquor filtered through asbestos, and mixed with twenty times its bulk of water. The subnitrate thus obtained was washed, dried, and reduced with lamp-black.

Antimony.—This metal was pulverised and fused with a mixture of pure nitrate and carbonate of soda; the antimoniate of soda so produced was washed with boiling water until the filtrate was no longer alkaline. The insoluble mass was dried and reduced with lamp-black.

Lead.—Nitrate of lead was re-crystallised, and, when pure, the salt was dried and calcined. The oxide of lead so prepared was reduced by lamp-black.

Zinc.—Vieille Montagne zinc was redistilled twice.

Cadmium.—The metal was obtained pure by dissolving in hydrochloric acid, and passing sulphuretted hydrogen into the liquor. The sulphuret of cadmium was well washed with a solution of sulphuretted hydrogen and dissolved in hydrochloric acid; carbonate of ammonia was added, and the precipitate was washed, dried, mixed with lamp-black, and the cadmium distilled.

The platinum, aluminium, iron, and sodium which we used were only commercially pure.

As the determination of the power of metals to conduct is of great importance, we shall give here a detailed record of the results obtained:—

NAMES OF THE METALS.	Temperature of the 50 cubic cent. of water before beginning.	Temperature of the 50 cub. cent. after 15 minutes.	Conductibility found.	Mean.	Conductibility. Silver = 1,000.
	Degrees.	Degrees.			
Silver $\frac{1000}{1000}$	19·8 19·7	51·6 51·7	31·8 32·0	31·9	1000
Gold $\frac{1000}{1000}$	14 13·6	45·4 44·8	31·40 31·20	31·30	981
Gold $\frac{991}{1000}$	20·3 20·3 20·0	47·3 47·0 46·7	27·0 26·7 26·7	26·80	840
Copper (rolled)	19·5 20·0 21·6 20·5	46·3 47·1 48·0 47·45	26·8 27·1 27·0 26·95	26·95	845
Copper (cast)	21·30 21·45	47·2 47·3	25·90 25·83	25·87	811
Mercury	15·0 16·6	36·7 38·1	21·7 21·5	21·60	677
Aluminium	18·2 17·7	39·3 39·0	21·1 21·3	21·20	665
Zinc (rolled)	18·4 19·9 18·5	39·0 40·2 38·9	20·6 20·3 20·4	20·45	641
Zinc (cast vertically)	19·6 19·2 14·0	39·8 39·1 35·0	20·2 19·9 20·0	20·03	623
Zinc (cast horizontally)	20·6 20·8	40·0 40·2	19·4 19·4	19·40	608
Cadmium	18·0 16·5	36·5 34·8	18·5 18·3	18·40	577
Malleable iron	18·70 19·05	32·6 33·0	13·9 13·90	13·92	436
Tin	20·5 21·2	34·0 34·6	13·55 13·4	13·45	422
Steel	15·2 15·5	27·8 28·2	12·6 12·7	12·65	397
Platinum	15 14	27·1 26·2	12·1 12·2	12·15	380
Sodium	14·2 14·1	25·9 25·7	11·7 11·6	11·65	365
Cast iron	14·9 15·6	26·4 27·0	11·50 11·40	11·45	359
Lead	20·5 18·3	29·70 27·45	9·20 9·15	9·17	287
Antimony (cast horizontally)	14·6 14·3	21·5 21·1	6·9 6·8	6·85	215
Antimony (cast vertically)	19·2 18·9	25·30 25·05	6·10 6·15	6·12	192
Bismuth	19·0 18·3	21·00 20·20	2·00 1·90	1·95	61

From the details given in describing the apparatus used in our experiments and the methods followed, it will be easy to perceive that for the solid metals we always employed square bars, 1 c. m. square and 6 c. m. long. These bars were always cast of a larger size than required, and were filed down to the exact dimensions. For mercury and sodium we were obliged to have recourse to other methods of operating. We employed a very thin sheet-iron box, the internal dimensions of which were exactly those of the square metallic bars which we usually employed. To admit the mercury, there was in the middle of one of the longitudinal surfaces a small hole, 4 millims. in diameter, and when full of mercury the hole was stopped by a little thick caoutchouc varnish. The box was then weighed, by which it was easy to ascertain if it was quite full. It was then introduced into the two vulcanized india-rubber boxes, and the conducting power of the mercury and box determined. By subtracting the special conducting power of the box (which had previously been ascertained) from the total conducting power of the box and mercury, the difference was the conducting power of the mercury as given above. We operated in the same way with sodium, with this difference, that we melted the sodium under benzine, and whilst fluid filled the box with it. Of course we cannot pretend that the figures which we give in these two instances represent their exact conducting power, but they are at all events very near the truth. We endeavoured to ascertain the conducting power of potassium in the same way, but failed, owing to the tendency which potassium has to granulate when melted under benzine.

We think it our duty to state that we are aware of the respective works of M. Langberg and of MM. Wiedemann and Franz, but that we have not followed their thermo-electrical process, as we deemed our method capable of giving more direct and reliable results. We have, however, great pleasure in confirming their results with reference to the superior conducting power of silver to that of gold, though the order of conductibility of the other metals as determined by our process is different from theirs.

In determining the conducting power of metals great attention must be paid to their physical state, as their conductibility is modified by their molecular condition.

Influence of Molecular Condition.

We found that the conducting power of several metals was different when they were rolled out into bars, or when cast. Thus, for example,—

	Conductibility found.	Conductibility. Silver = 1,000
Rolled copper......	26·95	845
Cast Copper	25·87	811

It is probable that the reason why rolled metal conducts heat better than the same metal when simply cast, is that the molecules composing the rolled metal are in closer contact than those composing the cast metal, owing to the process of rolling; and it is worthy of observation that this view agrees with Mr. J. P. Joule's theory, that heat travels in bodies by the vibration of matter, and not by the fluid called caloric, travelling between the interstices of the molecules.

Influence of Crystallisation.

The influence of the molecular arrangement is clearly illustrated in the following examples, where it is seen that the conducting power of zinc, antimony, and bismuth is modified according to the axes of crystallisation. Thus the conducting power of zinc is different if the sample for experiment is cast horizontally or vertically; for example,—

	Conductibility found.	Conductibility. Silver = 1,000
Zinc cast vertically......	20·03	628
Zinc cast horizontally...	19·40	608

If these two square bars be broken and examined, they present a very great difference.

The one cast vertically has four axes of crystallisation all starting from the centre and proceeding towards each angle of the bar. The one cast horizontally has one centre line or axis of crystallisation, which divides the square bar into three parts.

The results obtained with antimony are the following:

	Conductibility found.	Conductibility. Silver = 1,000.
Antimony cast vertically ...	6·12	192
Antimony cast horizontally	6·85	215

We shall refer to the extraordinary influence exercised by crystallisation on conduction of heat when we examine some of the alloys.

INFLUENCE OF SMALL AMOUNTS OF IMPURITIES ON THE CONDUCTING POWER OF METALS.

We have thought that it would be useful to ascertain the influence which one per cent. of a metal exercises when added to another, and these are the curious results obtained with gold and silver:—

	Found.	Conductibility. Silver = 1,000.
Pure gold	31·31	981
Gold with 1 per cent. of silver	26·80	840

Therefore the addition of 1 per cent. of silver, the best conductor, to gold, diminishes its conducting power nearly 20 per cent.

We have observed much more marked examples of the diminution of conductibility of a metal by the addition of 1 per cent. of another metal, for example, whilst the conducting power of pure mercury is 21·60, it is only 13·15 when amalgamated with 1·25 per cent. of tin. Professor W. Thomson having lately discovered that a small quantity of various metals added to copper greatly modifies the conduction of electricity by this metal, we deemed it advisable to try if the conduction of heat by copper would also be altered if we were to alloy it with 1 per cent. of various other metals. We were fortunate enough to obtain results which coincide with his, namely, that some metals increase the conduction of heat by copper, whilst others diminish it.

We have also examined the influence which carbon exercises on the conductibility of iron, and we hope that the results observed will prove useful in a commercial point of view; for as seen by the figures obtained, the difference is about equal to 18 per cent. The following are the results:—

	Found.	Conductibility. Silver = 1,000.
Malleable Iron*	13·92	436
Steel	12·65	397
Cast iron	11·45	359

We also thought that it would be interesting to ascertain what would be the influence of another non-metallic substance on a metal, and we accordingly made the following series:—

	Found.	Mean.	Conductibility. Silver=1,000.
Cast copper	......	25·87	811
Copper with 1 per cent. of arsenic ...	18·1 18·3	18·20	570
Copper with 0·5 per cent. of arsenic	21·3 21·4	21·35	669
Copper with 0·25 per cent. of arsenic	24·7 24·5	24·60	771

These results confirm the influence of a non-metallic body on the conductibility of a metal. It is interesting to observe that the influence of arsenic on the conduction of heat on copper is in ratio with the increased quantity of arsenic.

We have also examined a great number of alloys with the hope of throwing some light on their chemical composition, and we trust that the facts which we are about to describe will not only tend to illustrate this point, but will also be of interest from the new and various results observed.

We have also made a great variety of experiments with the view of ascertaining if there be a general law in connexion with the conduction of heat by alloys, and although we could not trace any general rule, still we observed several useful facts.

The conduction of heat by alloys may be considered under three general heads:—

1. Alloys which conduct heat in ratio with the relative equivalents of the metals composing them.

2. Alloys in which there is an excess of equivalents of the worse conducting metal over the number of equivalents of the better conductor, such as alloys composed of 1Cu and 2Sn; 1Cu and 3Sn; 1Cu and 4Sn, &c., and which present the curious and unexpected rule that they conduct heat as if they did not contain a particle of the better conductor; the conducting power of such alloys being the same as if the square bar which we were examining was entirely composed of the worst conducting metal. A not less remarkable fact is that the alloys of a series such as those of 2 equivalents of bismuth and 1 of lead, 3Bi and 1 Pb, 4Bi and 1Pb, 5Bi and 1Pb, all conduct the same, viz., about 1·9, the various increasing quantities of lead exercising no influence on the conductibility of the alloys. The results obtained with this class of alloys are most important to engineers; for it will be seen in the case of the alloys of brass and bronze, that no increase is gained in the conductibility of an alloy by increasing the quantity of a good conductor; nay, in many cases it would be a decided loss, unless a sufficient quantity of the better conducting metal be employed to bring the alloy under the third head.

3. Alloys composed of the same metals as the last class, but in which the number of equivalents of the better conducting metal is greater than the number of equivalents of the worse conductor; for example, alloys composed of 1Sn 2Cu; 1Sn 3Cu; 1Sn 4Cu: in this case each alloy has its own arbitrary conducting power; the conductibility of such an alloy gradually increases and tends towards the conducting power of the better conductor of the two metals composing the alloy.

Before describing the experiments which relate to these three classes of alloys, we deem it advisable to state, that from the numerous assays which we have made, we are led to believe that the conduction of heat by alloys is greatly modified by the crystalline system to which each of the metals composing them belongs, or by the peculiar crystalline form of its own crystals; for we have observed that some of the crystallized alloys of copper and tin, and copper and zinc, have a special conducting power of their own; for example—

	Found.	Calculated.	Silver = 1,000. Found.	Silver = 1,000. Calculated.
Tin, 1 equivalent......... 38·21 Copper, 3 equivalents... 61·79 100·00	15·75	21·37	494	670
Tin, 1 equivalent .... 31·73 Copper, 4 equivalents... 68·27 100·00	4·96	21·88	155	686

Whilst the alloys which present little or no crystalli-

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* The iron was manufactured from the same cast iron as that used in this experiment, and both were identical to those used by Mr. Joule in his thermo-electrical experiments. Their composition was as follows:—

	Analysis of Cast Iron.	Wrought Iron.
Carbon	2·275	0·296
Silicium	2·720	0·120
Phosphorus	0·645	0·139
Sulphur	0·301	0·134
Manganese and aluminium ...	traces	
Iron	94·059	99·311
	100·000	100·000

zation have a conductivity which is in ratio to the equivalent quantities of the metals composing them; for example—

	Found.	Calculated.	Silver = 1,000 Found.	Silver = 1,000 Calculated.
Lead, 1 equivalent ...... 36·99 Tin, 3 equivalents ...... 63·01 100·00	11·96	11·86	375	372
Lead, 1 equivalent ...... 30·56 Tin, 4 equivalents ...... 69·44 100·00	12·17	12·14	381	381

The method which we have followed to calculate the theoretical conducting power of our alloys is the following:—

Multiply the per-centage quantity of each metal by the respective conducting power of that metal, add the results together and divide by 100; for example, in the alloy Pb 3Sn,

Pb 36·99× 9·17 = 339·19
3Sn 63·01× 13·45 847·48
100)1186·67
11·86 the theoretical conducting power of the alloy.

We have also taken care always to cool the alloys rapidly, so as to render their mass of a more uniform composition, and prevent, especially in copper and tin alloys, the formation of various crystalline compounds having different compositions.

The first class of alloys which we shall describe, are those which conduct heat in the ratio of the conductibility of the metals composing them. This class is represented by the alloys of tin and lead, and tin and zinc.

TIN AND LEAD.

Formula of the alloys and Per-centage.	Found (Mean).	Calculated.	Silver = 1,000. Found.	Silver = 1,000. Calculated.
5Sn = 73·97 1Pb = 26·03	12·28	12·30	385	386
4Sn = 69·44 1Pb = 30·56	12·17	12·14	381	381
3Sn = 63·01 1Pb = 36·99	11·96	11·86	375	372
2Sn = 53·18 1Pb = 46·82	11·16	11·16	350	350
1Sn = 36·22 1Pb = 63·78	10·52	10·72	230	236
1Sn = 22·11 2Pb = 77·89	10·00	10·11	313	317
1Sn = 15·91 3Pb = 84·09	9·91	9·85	311	309
1Sn = 12·44 4Pb = 87·56	9·60	9·69	301	304
1Sn = 10·20 5Pb = 89·80	9·55	9·60	299	301

TIN AND ZINC.

Formula of the alloys, and per-centage.	Temperature of the 50 cub. cent. before beginning.	Temperature of the 50 cub. cent. after 15 minutes, from 5 to 5 minutes.			Conductibility found.	Mean.	Calculated.	Silver = 1,000. Found.	Silver = 1,000. Calculated
	DEG.	DEG.	DEG.	DEG.					
5Zn = 73·43	17·0	24·9	30·3	34·2	17·2	17·25	18·25	541	572
1Sn = 26·57	17·0	24·7	30·2	34·3	17·3				
4Zn = 68·86	16·4	24·3	30·5	34·7	18·3	18·3	17·99	574	564
1Sn = 31·14	16·0	24·1	30·0	34·3	18·3				
3Zn = 62·43	17·6	25·3	30·5	34·4	16·8	16·9	17·57	530	551
1Sn = 37·57	16·7	24·5	29·9	33·7	17·0				
2Zn = 53·11	18·5	26·4	31·5	35·2	16·7	16·65	16·95	522	532
1Sn = 46·89	17·5	24·9	30·3	34·1	16·6				
1Zn = 35·61	18·1	25·5	30·5	34·1	16·0	16·00	15·80	501	495
1Sn = 64·39	17·4	24·6	29·8	33·4	16·0				
1Zn = 21·65	17·1	23·8	28·7	32·3	15·2	15·15	14·90	475	467
2Sn = 78·35	16·6	23·3	28·2	21·7	15·1				
1Zn = 15·55	17·5	24·3	28·9	32·2	14·7	14·6	14·39	458	451
3Sn = 84·45	17·6	24·4	28·9	32·1	14·5				
1Zn = 12·14	17·3	23·8	28·7	32·0	14·7	14·6	14·25	457	447
4Sn = 87·86	17·5	23·8	28·8	32·0	14·5				
1Zn = 9·95	17·1	23·6	28·4	31·7	14·6	14·55	14·10	456	442
5Sn = 90·05	17·0	23·4	28·2	31·5	14·5				

The above two series of alloys are the only ones which conducted heat, as above stated; and from experiments which will be described further on, we believe that the metals composing these alloys are simply mixed, and not combined together.

(*To be continued.*)

NEW HORTICULTURAL GARDEN AT KENSINGTON GORE.

A model, showing how the ground will be laid out in terraces, for the garden of the Horticultural Society, has just been placed in the South Kensington Museum, at the north end, near the entrance to the ornamental art rooms. Between the Kensington-road and Cromwell-road, the ground falls about 40 feet, and using this fact in aid of a general effect, the ground has been divided into three principal levels. The entrances to the gardens will be on the lower level, in Exhibition and Prince Albert-roads, and the central pathway, upwards of 75 feet wide, ascending through terraces to the third great level, will lead to the Winter garden. The whole garden will be surrounded by Italian arcades, each of the three levels having arcades of a different character. The upper or north arcade, where the boundary is semi-circular in form, will be a modification of the arcades of the Villa Albani, at Rome. The central arcade will be almost wholly of Milanese brickwork, interspersed with Terra Cotta, Majolica, &c., whilst the design for the south arcade has been adapted from the beautiful cloisters of St. John's Lateran, at Rome. None of these arcades will be less than 20 feet wide and 25 feet high, and they will give a promenade, sheltered from all weathers, more than three-quarters of a mile in length. The arcades and earthworks will be executed by the Commissioners for the Exhibition of 1851, at a cost of £50,000, whilst the laying out of the gardens and construction of the conservatory, or Winter garden, will be executed by the Horticultural Society, and will cost about the same sum, the greater part of which has been already raised.

THE SALT TRADE.

The Report presented to the Annual Meeting of the Salt Chamber of Commerce,* held on the 5th August, has just been issued.

The Report says that the two leading questions in connexion with the amelioration of the trade, are the facility of being allowed to import salt into China, and to extend the trade already in operation with India. As regards the former, a deputation from the chamber had an interview with Lord Elgin, when his Lordship stated that, up to the time of his negociating the Chinese treaty, no allusion whatever had been made to the subject of a salt import, nor had Sir John Bowring brought it under his notice. The Chinese were so very poor that any interference with their revenue was a difficulty; but if arrangements could be made with the Chinese Government, or it could be shown that they would be benefited by the admission of English salt, other difficulties might be removed. They were much afraid of smuggling, but it was pointed out to Lord Elgin that the bulky nature of salt placed it on a very different footing to opium, which was now legally admitted into China.

The deputation pointed out to his lordship the success which had attended the import of salt into Calcutta, and the large revenue it yielded to the Indian Government, and he expressed his willingness to further the views of the Chamber in obtaining the admission of British salt into China, and that he would be glad to receive any commmunication on the subject, as also to write to his brother, Mr. Bruce, thereon.

Upon the favourable information thus afforded, the Chamber proceeded to prosecute measures for obtaining the support of Her Majesty's Government, and presented the following memorial—to Lord John Russell, as Secretary of State for Foreign Affairs:—

> "The Memorial of the Salt Chamber of Commerce respectfully sheweth, that during the past year representations were made to the Foreign Office as to the great advantages that would result from opening up a trade in British salt with the vast Empire of China, both to the salt manufacturers and to British shipowners, who are always greatly at a loss for bulky articles wherewith to assist in loading their ships to that country.
>
> "That, unfortunately, the new treaty with China had been concluded before the attention of his Excellency Lord Elgin was called to the subject, otherwise your memorialists are assured the admission of salt might have been stipulated for in that treaty on some equitable principle, calculated to protect the Chinese Revenue, which is supposed to be largely dependent on the article of salt.
>
> "That previous to the departure of the newly appointed Ambassador to Pekin, his Excellency was made conversant with the position of the salt trade in England, and the facilities it afforded for supplying the Chinese with a pure manufactnred article at a very moderate cost, his Excellency being also furnished with samples of salt to illustrate the superiority of British salt, over the article used in China.
>
> "That the consumption of salt is, of necessity, enormous amongst the teeming population of China, and an easy method for collecting a large revenue upon imported salt would thus be *pointed out to the* Chinese Government.
>
> "That the example of India may be cited as an analogous case, inasmuch as a change in the fiscal regulations concerning salt there, has led to an import of about 100,000 tons per annum of English salt at Calcutta (Bengal being the only Presidency where it is yet practically admitted), upon which a revenue of nearly half a million sterling per annum is collected by the Government at a very small cost to themselves, and your memorialists believe that his Excellency would have no difficulty in proving to the Chinese Government that it would be equally to their interest to admit English manufactured salt on similar principles.
>
> "Your memorialists, therefore, pray your Lordship will be pleased to direct the special attention of his Excellency the Ambassador to the Court of Pekin to this subject, which is of the most vital consequence to the salt and shipping interests of this country, both suffering greatly from a want of outlets and employment of their respective produce and property, and your memorialists bring this subject under your Lordship's notice in this form, at the recommendation of several Members of the House of Commons and of the Lords, who take a deep interest in the question, assured that it will thus receive your Lordship's prompt and earnest attention.
>
> "W. WORTHINGTON, Chairman.
>
> "Dated Northwich, 25th July, 1859."

The Chamber look forward to a satisfactory result from their labours in this direction; and as regards India, the report states that it only appears to be a question of time, in making our own authorities fully comprehend what is wanted from them. It appears from a letter addressed by the Secretary to Mr. Tollemache, M.P., on the 25th July last, that the principal requirements are:—Bonding accommodation for salt at Bombay and Madras on the same principle as at Calcutta; increased bonding storage for salt at Calcutta; equalisation of duties (excise and customs) at all the Presidencies, as suggested by the Chamber of Commerce at Calcutta to Lord Canning; that the Government should give up the system of manufacturing salt in India themselves, thus interfering with private enterprise.

Attention is drawn to the fact that the price of labour has risen very much in India, so that there is less reason for making salt as a means of employing an idle population.

The facility of raising a revenue on salt imported should not be overlooked, being an important question in the present depressed state of Indian finances.

No communication has been made by the Calcutta Chamber of Commerce in answer to the letter of this Chamber, asking for their co-operation, and for such suggestions as might be useful in guiding their proceedings; but in their memorial to the Governor General some time back, the Calcutta Chamber made strong allusion to the raising of revenue by additional duty on salt, and equalising the duty at the other Presidencies of Bombay and Madras, where it was considerably less than in Bengal. Sir Charles Wood, on propounding his financial statement for India, looked to additional revenue (£300,000) from an increase of the salt duty at these Presidencies, so as to equalise them with those of Calcutta—a measure that would speedily open to us these markets, as it would then become an object to pay the same duty on a superior article rather than on an inferior one. The rate of duty at the three Presidencies is now as follows:—

Calcutta,	5s. per maund.	According to the information given by Mr. Prideaux, of the East India House.
Bombay,	2s. do.	
Madras,	1s. 6d. do.	

The Report goes on to say that, in the present position of Indian finances the raising of a large revenue on imported salt will no doubt occupy the serious attention of the local government as well as of the imperial one, and it is believed this may be done without unduly pressing on the native population, as much abuse is said to exist in the mode of administering the excise duties as well as in the process of manufacture adopted by the late Company. A duty levied on imported salt goes at once into the Exchequer at a very moderate expense for its collection, whereas, under the present system, the nett amount of revenue on salt is not believed to correspond at all with the gross amount.

Another market to which the attention of the Chamber has been directed is that of the River Plate, where for many years an import of salt from Europe has taken place, averaging from 30,000 to 50,000 tons per annum; it was supposed that English salt would not suit for the curing of hides and salted beef, and that restrictions of government existed which prevented the importation of English salt, but experiments made with several cargoes from Liverpool have proved not only that the salt will rank even superior to that of Cadiz, which is the most esteemed there, but the Liverpool shipments have arrived opportunely and left a considerable profit. An attention to the quality of rough-grained salt, suitable for River Plate consumption, is therefore very desirable.

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* An account of some of the proceedings of this Chamber appeared in the *Journal*.—(See Vol. VI., p. 678.)

ON A UNIVERSAL PRINTING PRESS.*

BY T. J. SILBERMAN, Jr.

A press on this principle, and adapted to all kinds of printing, has been patented by Mr. Silberman, pupil and assistant in physics to the late M. Savart, and to M. V. Regnault, at the College of France.

Pascal's law is this:—"Whatever be the amount of pressure brought to bear upon any point in a contained fluid mass (whether the fluid be a liquid, or steam, or gas), this pressure is distributed with perfect and entire equality among all parts of the mass, and consequently with perfect equality over all parts of the surface of the vessel which contains the mass;" so that if this vessel or a portion of it be pliable and elastic, it will communicate the same pressure which it receives to paper, cloth, or any other similar substance, laid upon an unyielding engraved surface. And the invention consists in printing by thus applying the pressure of a fluid to a yielding surface laid against an unyielding engraved surface; and this whether the surface printed be that of the vessel itself, which thus becomes the press,—or whether it be communicated to another interposed yielding surface from the pliable and elastic side of the vessel, so as to print plane, curved, or angular surfaces,—or whether the material to be printed be paper, felt, textile fabric, caoutchouc, leather, bladder, ceramic paste, or glass, crystal, or enamel softened by heat,—or whether it be used for the purpose of peripheric printing, as in the printing of terrestrial and celestial globes, of vessels of glass and earthenware,—or as a modification of the presses in use for other kinds of printing.

The application of this principle to the peripheric printing of globes, and of vessels of glass and earthenware, is the subject of a separate paper. At present let us consider merely its application to printing upon plane surfaces, as well as the different modifications it admits of, so as to suit the different kinds of printing; and lastly, of its peculiar advantages over other methods.

The following are some of the methods in use for the practical application of the principle:—

1. A strong shallow basin of tough metal is required, with a triple stop-cock at bottom, admitting at pleasure the sort of fluid intended to be used, whether it be atmospheric air, steam, or (when great pressure is required) water, with hydraulic pressure. This basin is filled with water, and covered by a tympan formed of a sheet, or of several sheets thick of caoutchouc firmly clasped at the edges in an iron frame. A moveable plate of iron, strengthened by stays, is attached by strong hinges to one of the edges of the tympan frame. This plate, when shut down upon the surface of the tympan, forms the unyielding portion of the press, and supports the engraved plate against the substance intended to be printed, which receives by means of the tympan the pressure produced upon the water at the bottom of the basin.

In order to retain this plate firmly in its place upon the tympan, its edges as well as those of the basin should be bevelled in such a manner as to lock the whole way round in a collar with a corresponding groove; this collar opens and closes upon the edges the whole way round by means of two hinges and wide-threaded strong screws, or else by means of a cam or eccentric lever lock. A very simple contrivance compels regularity in the proceeding, and prevents accidents, by locking the stop-cock, and preventing the admission of pressure into the basin, until after the plate shall have been shut down and firmly locked upon the tympan.

The engraved plate may either be permanently fastened upon the iron plate, or it may be run into its place in a groove, so as to admit of being easily removed and replaced after each impression, as in the case of copperplate printing.

When it is intended to print paperhangings or cloth with dies, an iron frame instead of the solid plate above described is attached to the hinges; a strong iron axle passing through gudgeons on opposite sides of the frame carries a panel fitting into the frame, and upon this panel the die is fixed. The panel thus revolving completely on the axle at the same time that the frame is raised upon its hinges to a vertical position, admits of the face of the die being alternately brought into contact with the tub, when it is charged with colour, and with the surface of the material intended to be printed.

2. Another form of the press is one in which the tympan is moveable upon hinges, and fastens down upon the plate, which in this case is the fixed part of the press, and upon it the die is laid. In lithography or typography there must of course be a hollow in the plate corresponding to the thickness of the stone or type used.

This was the form adopted for the first experiment with the press; its tympan consisted of two sheets of vulcanized caoutchouc fastened to the basin, and secured by strong screws; the tympanum and the plate, instead of being locked together while the pressure was on by means of the collar above described, were kept together at one end by the hinges, and at the other by a cam or eccentric lever lock, working from an iron arch like a common letter-copying machine, and to which two moveable claws are attached, which, when the lever is worked, grasp and secure the ends of a strong bar across the centre.

3. It may sometimes be desirable to place the press vertically, notwithstanding the slight, and in fact almost imperceptible difference in the pressure at the top and at the bottom of the basin, and which is produced by the column of water in the basin itself. When air is used this inequality is absolutely imperceptible, but on account of the great compressibility of air a much larger quantity of air must be admitted that when water is used; for instance, if the basin is one metre square and one millimetre deep, and consequently holds one litre, it will require one litre of air to produce a pressure of a single atmosphere, and ten litres to produce a pressure of ten atmospheres.

The vertical position is particularly well suited for very large plates, say five or six feet square; the copperplate can if necessary be heated from behind, and the workman can apply the ink in a standing posture. The press in this case would open like a door, and large presses thus arranged would occupy but little space, would be easily worked, would render the application of the ink less fatiguing, and would save rent in office space, for six vertical presses take no more room than two horizontal presses. In this way the printing of very large maps will become not only possible but cheap.

As to the purposes to which it can be applied:—1. It is equally suitable to all kinds of ordinary printing, whether copperplate, lithography, typography, paperhangings, or wood engraving, for it fully admits of the depth of shade in certain parts of the engraving being modified according to taste, without altering the engraving by the usual contrivance of folds of paper cut out so as to throw the part into suitable relief.—2. It is peculiarly suitable for polychromic printing, whether typographic, lithographic, or copperplate, and the pressure being only in a vertical direction, the paper or cloth is not liable to be altered in size or form by the pressure, and admits of accurate fitting to the guide pins as often as the number of colours used may require. 3. It is equally suitable for printing upon all sorts of material, whether paper, cloth, ceramic paste, felt, leather, or caoutchouc. 4. It prints with a single impression very much larger plates than it has heretofore been possible to do, and it ensures the colour being uniform over the whole surface. 5. It admits of being used for stereotype and other casts from ordinary printing type, and does not require that frequent touching with the brush which wears away the characters so quickly.

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* From the Civ. Eng. and Arch. Jour.

As to the pressure:—1. The pressure being that of a fluid communicated through a uniformly yielding surface, will be absolutely equal at every point of the surface, consequently there will be no danger of partial pressure on the plate, nor need there be a pressure upon any part of the plate beyond what is necessary, so that the maximum result is thus obtainable with a minimum of pressure. 2. Any amount of pressure required can be easily obtained. 3. The amount of pressure can be ascertained with precision (for instance, by Bourdon's metallic manometer), and diminished or increased to the exact extent which may be required. 4. Perfectly plane surfaces are no longer the only surfaces capable of being printed. 5. Convex or concave surfaces can thus be printed.

As to make, form, and size:—1. The press is extremely simple in its construction; almost all the pieces are cast exactly as they are used, and require very little fitting. 2. It can be made of any strength required. 3. It requires no troublesome alterations when the purpose for which it is used is altered. 4. It fits in a very small space, being only four or five inches wider than the printed sheet, whereas the presses hitherto in use are at least four times wider than the printed sheet. 5. It thus admits of being worked in a small and comparatively inexpensive office. 6. Its size being so small, a printer can have several presses of different sizes in his office, so as to be no longer forced to use his large presses for small sheets. 7. It is easily taken asunder and moved. 8. It is on this last account, and the almost impossibility of breakage, admirably adapted for exportation.

As to its working:—1. It requires hardly any effort, and entirely dispenses with the severe labour which the winches and pedals of the present lithographic press require,—with the rolling of copperplate printing,—with the difficulty of charging the blocks with colour, as well as with the danger of working the huge lever of the ordinary press in printing paperhangings; and as it requires less exertion on the part of the workmen, it gives them more time to attend to the quality of the work, and thus tends to elevate their character. 2. A much greater number of impressions can be taken in a given time than was possible heretofore. 3. The manner of using the press can be learned in an hour. 4. No modification of the press, or any of its parts, is necessary when a change is made in the size of the sheet, or otherwise in the nature of the work to be printed. 5. The impression is uniformly even and invariably successful. 6. There is no longer any danger of distorting or of lengthening by rolling out the plates in copperplate printing,—or of breaking the lithographic stones by the uneven pressure of the scraper. 7. The simplicity of the contrivance for locking the press, and for admitting and shutting off the pressure, renders all mistakes impossible. 8. There is no part of the press which is expensive from excessive wear and tear; and even when worn out, both the caoutchouc and the metal have a considerable value as raw material.

As an investment, the great simplicity of the machinery, and the small expense of fitting, will allow the press to be sold extremely cheap.

As to the sort of pressure to be used,—steam pressure may be adopted, or the pressure of expanded or condensed air, the hydraulic press, the screw, the cam, or the eccentric or knee lever lock. If steam is used, the waste heat will warm the plates in copperplate printing, and will thus get rid of the charcoal dust, so injurious to the health of the workmen.

The expenditure of water or steam may be estimated by considering the surface of the caoutchouc as the surface of a piston, and its depression joined to that of the printed surface as the stroke of the piston; consequently, when the basin is one metre square, there is an expenditure of one litre of air or water for each millimetre in the depression of the surface.

Water appears on the whole the most desirable agent, on account of its non-compressibility and of the small quantity required in order to produce very considerable pressure, as also on account of its non-expansibility, which prevents the possibility of an explosion, for if any breakage takes place the water simply runs out. In experiments which were made with a pressure of from 20 to 30 atmospheres, before perfecting the press, the vessel repeatedly burst, with no greater injury to those engaged than a few splashes on their clothes.

IRON-PLATED SHIPS.

A series of experimental trials have been recently carried on at Portsmouth with a view of ascertaining the amount of resistance offered by iron and steel plates of various manufactures when opposed to heavy ordnance at a short range. The trials are understood to have reference to the future coating of the steam ram now in progress of construction. The practice has been carried on from the Stork gun-boat, tender to her Majesty's ship Excellent, gunnery ship in Portsmouth harbour, both from a 32-pounder and a 95-cwt. gun, the latter throwing a solid 68-pound shot, with 16 lb. charge of powder; the distance of range 200 yards. At this distance the results of the experiments have demonstrated in the clearest possible manner that no iron or steel plate that has yet been manufactured can withstand the solid shot from the 95-cwt. gun at a short range. The first shot would not penetrate through the iron plate, but it would fracture it, and on three or four striking the plate in the same place, or in the immediate neighbourhood, it would be smashed to pieces. As the results of the trial affected the steel plates, it proved that a steel clothed ship could be far more easily destroyed than a wooden-sided one, and that, on the smashing in of one of the steel plates, the destruction of life on the armed ship's decks, supposing the broken plate to be driven through the ship's side, would be dreadful, from the spread of the splintered material. At from 600 to 800 yards iron-clothed vessels would be in comparative safety from the effects of an enemy's broadside, but it must be borne in mind that the effects of concentrated firing have yet to be ascertained on the sides of an iron or steel-clothed ship, and account must also be taken of the damage the woodwork forming the inner sides of such a ship would receive from the driving in of the broken plates, and which, as far as the present experiments have illustrated, would appear to prove that an iron or steel clad-ship, on receiving a concentrated broadside from a frigate, armed in a similar manner to the Mersey, and struck near her waterline, must sink with her armour on her back.

Home Correspondence.

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EXHIBITION IN 1862.

Sir,—It was suggested, I think by a writer in the *Daily News*, that a declaration on the part of England to hold a second Universal Exhibition, would be a fitting inauguration of an European peace, and a writer in the *Observer*, within the last few days, proposes that Government should at once declare its intention to hold such an Exhibition in 1862, and take steps to carry it out as a national measure, not to be interfered with by private bodies, such as the Society of Arts. Lord Lansdowne has said that "Government is the worst of traders, the worst of cultivators, and the worst of teachers." Is not the truth of the above remark made more and more evident every day? Does not every public department illustrate the fact that Government is the most dilatory of masters, the most wasteful of spendthrifts, and the most partial of employers that an artistic and commercial community can have to deal with?

Would England ever have seen an Universal Exhibition in 1851 if the Society of Arts had, not as it were, forced it upon the country? Have the Royal Commission, as Trustees of the surplus funds of the Exhibition of 1851, and which may be called a Government body, ever voluntarily proposed to hold a second great International Exhibition of the world's industry, as they were bound to do under the original deed of trust, and in accordance with the conditions under which the subscriptions from Sheffield and other towns were given, viz., upon the undertaking that should any surplus remain from the Exhibition of 1851, her Majesty's Commissioners would apply the same to purposes strictly in connection with the ends of the Exhibition, or for the establishment of similar Exhibitions in future?

Do great national undertakings ever emanate voluntarily from the Government of this country, and is it at all likely that England will ever see a second Universal Exhibition if it is left to the voluntary action of Government to propose and carry it out? I think not. I therefore sincerely trust that the hope held forth by the Chairman of the Council, in his address in June last, will be realised, and that so soon as the Society reassembles after its recess we shall see a declaration issued by the Council of its intention to at once renew its endeavours to carry out a second Universal Exhibition of the world's Art and Industry in 1862.

There is reason to hope that the war which threatened seriously to disturb the peace of Europe having passed away, and peace being re-established, a second Universal Exhibition would be calculated to bring about a renewal of friendly relations with our continental neighbours, inducing a friendly rivalry and competition between nations, and tending greatly to that extension of commerce which is sure to produce an increased desire on the part of all for enduring peace. An exhibition which really represents the world's industry can only be carried out successfully during peace, for how else would it be possible to gather the products of forty nations under one roof, as was the case in 1851. Many more should be added in 1862, seeing how much more generally the character and importance of such exhibitions is understood.

It cannot be denied that England, since 1851, has made great advances, especially in her Art Industries, and that she would now be able to stand forward much more boldly in competition with foreign countries than on the last occasion. France, too, which undoubtedly bore away the palm for her artistic displays of bronze, zinc, and other metal works, as well as for many other branches of applied design, would doubtless be glad to show how far she has profited by the visit of the ninety foremen and many first-rate workmen, who were sent over free to study the Exhibition of 1851, and the manufactures of Beauvais, Sèvres, Gobelins, Chalons, Aix, and Angers will be anxious each to show how they profited by the Exhibition of 1851, and that more recently held in Paris in 1855.

Moreover, the Art workmen of England will be desirous of showing how they have profited by the study of the works of Ancient Masters exhibited at Manchester, and the increasingly useful and beautiful collection of originals and copies of Art workmanship collected at the Brompton Museum.

The education of artisans in their respective trades has been greatly extended and improved throughout England, and the principles upon which manufactures of every kind are carried on are better understood by the rising generation of workmen than they were at the time of the last Exhibition. English artizans will therefore be in a position to take advantage more fully of future Exhibitions.

Having thus been employed in the education of producers, we are bound to take the most effective of all steps for the education of purchasers, namely, the holding another Universal International Exhibition.

Fearing to trespass longer on your space,

I am, &c., H. G. HAWARD.

Bow.

THE STONES OF LONDON.

SIR,—With reference to the letter of your correspondent, D. T. Ansted, on the subject of the incrustation of soft stone with soluble silicate of potash or soda, I beg to state that it is highly improbable that we shall ever very closely imitate the productions of nature by artificial means.

The wisest course, therefore, will be to make use of well-known durable stone only, and abandon all such architectural sculpture as, on account of expense, can only be executed in a soft perishable material, and which in the great metropolis is doubly useless. Soft stone will not stand our London atmosphere, and if it did, the black incrustation of sooty matter in the carved receptacles so disfigures it as to render it exceedingly disagreeable in appearance, as well as disgraceful to a people so advanced as we are. We are, indeed, fast going back to the dark (black) ages.

The great work of the present day, the New Palace of Westminster, already presents the appearance of a fantastic mass of charcoal and coke, totally incompatible with architectural beauty—the outline only being visible. But as that is cut up by innumerable pinnacles, surmounted with rusty iron vanes, stuck about them in every possible and impossible position, that outline does not materially differ from a view of chimney pots over any part of London. The capitals of the portico of St. Paul's are gone, the stone (Portland) being too soft to retain the carbonaceous incrustation. The statue of her Majesty, in white marble, at the Royal Exchange, weeps tears of soot, and the drapery is so smeared and smutted as almost to put to shame a kitchen scullion. It is not, however, in London only that we are disgraced by elaborate carving in soft stone. Look at Exeter Cathedral, where the poor saints are suffering perpetual martyrdom in the loss of hands and feet, heads and noses.

Seeing the great variety of choice, why has the inexhaustible deposit of Plymouth marble, as well as the old quarry of "Tilly Whim," on the coast of Dorset, been entirely overlooked by the professors appointed to search for durable stone for the construction of the New Houses of Parliament, intended, I suppose, to be a monument of our magnificence to after-ages, which they will never reach without perpetual repair and reconstruction.

May I be allowed to ask, also, why professors of geology were needed at all, when there was an eminent architect appointed, whose superlative talent as a designer has been so misdirected by the barbaric fashion of the day. An architect, according to Vitruvius, is bound to be acquainted with all the sciences connected with his profession. Knowledge of the most durable and suitable materials, and where to be found; Acoustics, Pneumatics (ventilation), Thermics (comfort, winter and summer), as well as a host of others too numerous to mention. In the present case a professor was called in to direct the ventilation at a great cost to the nation, without any very beneficial results, as he persists in ventilating upwards through the floor, instead of downwards. I may also ask who permitted the intolerable blunder of passing the ventilating shaft through the clock-tower, intended to carry four dial-plates, three being easy, but the fourth, owing to the backward movement, of difficult accomplishment.

I am, &c.,
HENRY REVELEY.

PATENT LAW AMENDMENT ACT.

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APPLICATION FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, September 9th*, 1859.]

Dated 5th August, 1859.

1806. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—A system of columns or monuments to be employed as sentry boxes, branch post and other offices, telegraph and fire-engine stations. (A com.)

Dated 13th August, 1859.

1869. R. D. Clegg and T. Saunders, Islington—Imp. in locks.

Dated 23rd August, 1859.

1926. W. H. Hill, Birmingham—An imp. in the manufacture of boxes or cases, and in fastenings for the same.
1928. W. Hollins and F. Hyde, Glossop, Derbyshire—Imp. in power looms for weaving, part of which improvements is also applicable to other machines driven by power.
1930. T. Richardson, New Bridge-street, Newcastle-on-Tyne—Imp. in treating copper ores.

Dated 24th August, 1859.

1931. G. Pearson, Manchester—Improved machinery for manufacturing boots and shoes.
1933. J. Henry, Bury, and J. E. H. Andrew, Audenshaw, Lancashire—Imp. in looms for weaving.
1934. J. Blake, Accrington, Lancashire—Imp. in steam and vacuum gauges.
1935. D. Russell, 1, Grove-cottage, Southampton-street, Camberwell, and J. Russell, 6, Devonshire-terrace, Queen's-road, Peckham—Improving the means of docking and lifting ships out of the water, for the purpose of examining and cleaning their bottoms, effecting any necessary repairs, fixing new screw propeller, rudder, raising sunken vessels, or anything else for which it is desirable to get at any portion of a vessel generally under water.
1937. J. Murray, Dublin—Imp. in the preparation and bottling or preserving of carbonated cod liver oil and other aerated liquids.
1938. C. T. Judkins, 22, Ludgate-street, London—Imp. in sewing machines.

Dated 25th August, 1859.

1939. H. Smith and T. W. Ashby, Stamford—An improved construction of harrow. (A com.)
1940. L. Perkins, Francis-street, Gray's-inn-road—Imp. in mills. (A com.)
1941. A. P. Chamberlain, New Orleans, U.S.—Imp. in machinery or apparatus for cutting cork, part of which improvements is also applicable to cutting paper, caoutchouc, and other substances.

Dated 26th August, 1859.

1943. J. Furrell, 5, Upper Phillimore-place, Kensington—Lock protector, consisting of an adhesive shield or cover to be placed over the keyhole of a lock for the purpose of ensuring that any access to the interior of the lock shall be readily detected.
1945. T. Bird, Manchester—Imp. in castors.
1946. J. M. Hetherington, Manchester—Imp. in machinery or apparatus for carding cotton, wool, and other fibrous materials.
1947. H. Grundt, America-square—Imp. in life boats.
1948. W. MacLellan, Glasgow—Imp. in rolling or shaping iron for railway spikes and other purposes.
1949. C. T. Boutet, 12, Chenies-street, Tottenham Court-road—A new mechanical mill proper for milling every sort of grains, dried or torrefied, such as coffee and cocoa.

Dated 27th August, 1859.

1950. C. Hanson, Huddersfield—An imp. in the chronometer escapement of a watch.
1951. F. Wrigley, Manchester—Certain imp. in the construction of the permanent way of railways.
1952. J. R. Rostron, Edenfield, Lancashire—Imp. in furnace bars.
1953. W. H. Balmain, St. Helens, Lancashire—Imp. in the manufacture of glass, and other vitrified substances.
1954. T. Craven, Scarborough—Imp. in ball cocks or valves.
1955. G. Bell, South Inch Michael, Perth, N.B.—Imp. in reaping and mowing machines.
1956. J. Heckethorn, 32, Stanmore-street, Caledonian-road—Imp. in candles and wicks, and also in lamps and candlesticks for using with the same.
1958. E. Rettig, New-cross, Kent—Imp. in the form and construction of anchors. (Partly a com.)

Dated 29th August, 1859.

1960. T. Morton, 39, Pinnasberg, Saint Pauli, Hamburg—Imp. in governors for regulating the speed of marine and other engines and machinery.
1961. C. Kerman, Vulcan Iron Works, Millbrook, near Southampton—An apparatus to prevent the sinking of vessels through leakage, for lifting and floating vessels off when stranded, and for raising and floating sunken vessels.
1962. J. R. Howarth, Manchester—Certain imp. in machinery or apparatus for calendering and finishing textile fabrics or other surfaces.
1963. W. Clark, 53, Chancery-lane—Certain imp. in sewing and stitching by machinery. (A com.)
1965. D. Todd, Bridge-of-Weir, Renfrew, N.B.—Imp. in machinery or apparatus for carding and treating or preparing fibrous materials.
1966. B. Baugh, Bradford-street, Birmingham—Certain improved machinery or mechanical arrangements for raising or giving form to articles formed of sheet metal, such as knobs, thimbles, ferules, and parts of umbrella and parasol furniture, button shells, and other such like small articles.
1967. G. S. Fleming, 498, New Oxford-street—A head-rest, suitable for keeping the head in a comfortable position in travelling, sitting, or lying down.

Dated 30th August, 1859.

1969. J. B. Barnes, Summer-lane, and J. Loach, Caroline-street, Birmingham—Certain imp. in oars for impelling boats, as also in the row-locks in which they work.
1971. J. Hare, Hamstead-road, Handsworth, near Birmingham—Imp. in pianofortes.
1975. C. Chambers and J. Chambers, Archer-street, Westbourne grove, Middlesex—Imp. in apparatus for sawing staves and other forms of wood.
1977. R. F. Drury and E. Drury, Sheffield—Imp. in vices.

Dated 31st August, 1859.

1979. J. Nuttall, Todmorden—Certain imp. in and applicable to machinery used in preparing and spinning cotton and other fibrous materials.
1981. R. Beverley, Leeds—Imp. in wet gas meters.
1983. S. Middleton, Blackfriars-road—Imp. in the mode or method of uniting and otherwise manufacturing articles of leather, and such like materials, and in the apparatus and machinery connected therewith.
1985. A. Smith, Brentwood—Imp. in machinery for the preparation of cocoa nut fibre.
1991. J. Chatterton, Devonshire-street, Islington—Imp. in the manufacture of tubes of gutta percha, and other substances capable of being moulded in a similar manner when in a plastic state, and also in coating wire and other cores with such substances.

Inventions with Complete Specifications Filed.

1942. M. Billing, High Holborn—An improved mode of ornamenting and finishing certain articles of hardware.—26th August, 1859.
1944. M. J. Stark, Norwich—Producing a new chemical or artificial manure from bones, and all such animal and fatty matters.—26th August, 1859.
2032. J. J. Sieber, 5, Baring-street, New North-road—Imp. in power-looms.—Dated 6th September, 1859.

WEEKLY LIST OF PATENTS SEALED.

[*From Gazette, September 9th*, 1859.]

September 8th.

613. J. Erwood & J. Skertchly.
621. J. Yuill.
623. H. Lodge.
627. S. Wheatcroft.
629. F. Clark.
635. J. T. Calow.
636. J. Thornton.
637. J. Court.
638. R. Allison.
639. J. Macnab.
640. R. Waller.
641. R. A. Brooman.
644. D. Joy.
649. W. Langton.
668. J. Clark.
670. H. Bessemer.
722. W. Weild.
753. W. Clark.
772. C. J. Richardson.
778. T. Carr.
1042. T. Holt and J. Brown.
1347. A. Suter.
1454. A. V. Newton.
1527. W. E. Newton.

Patents on which the Stamp Duty of £50 has been paid.

[*From Gazette, September 9th*, 1859.]

September 6th.

2087. F. Estivant.
2095. W. Petrie.

September 7th.

2093. F. M. Herring.
2126. J. Milnes & W. Thompson.
2130. A. D. Bishod.

[*From Gazette, September 13th*, 1859.]

September 8th.

2089. J. Fowler, jun,
2113. J. Taylor.
2129. A. Chaplin.
2149. C. Hill.

September 10th.

2140. J. Elliott.
2144. R. Peyton.
2150. S. C. Lister.
2165. G. T. Bousfield.